

*University of Minnesota  
Agricultural Experiment Station*

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to Fusarial Head Blight in Minnesota**

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# SUSCEPTIBILITY OF WHEAT VARIETIES AND HYBRIDS TO FUSARIAL HEAD BLIGHT IN MINNESOTA

J. J. Christensen, E. C. Stakman, and F. R. Immer

## INTRODUCTION

The only effective method of controlling wheat scab (Fusarial head blight) is to grow resistant varieties. While cultural methods will reduce losses somewhat, they can not be depended upon to control the disease adequately. With the increase in acreage of corn in the spring wheat area, Fusarial head blight is likely to become even more prevalent and destructive than it now is. The use of resistant varieties of wheat will therefore assume increasing importance. It will be necessary either to grow resistant varieties already available or to develop new ones. In either case a knowledge of the relative resistance of varieties now in existence will be very valuable. Therefore the tests described in this paper were made.

Relatively little has been done in determining varietal resistance of wheat to scab. Arthur (2), in 1891, was the first to report differences in varietal susceptibility to Fusarial head blight of wheat. Schmitz (14), Atanasoff (3), MacInnes and Fogelman (13), Hurd (11), Hayes (10), Stakman, Lambert, and Flor (17), and Wollenweber (19) have called attention to varietal differences, but none reported extensive studies. Christensen and Stakman (7), in a preliminary note, reported marked differences in susceptibility of varieties of durum and common wheats. They also found that certain strains from crosses between susceptible and resistant parents were as resistant as the resistant parent. Recently Scott (15) reported the results of tests with winter wheats that had been inoculated artificially with *Gibberella saubinetii* (Mont.) Sacc.

## MATERIALS AND METHODS

During the last nine years more than 350 spring varieties, selections, and hybrids of *Triticum spp.* have been tested for relative susceptibility to scab at University Farm, St. Paul, Minnesota.<sup>1</sup> Most of them were tested for at least three years, some for one or two

<sup>1</sup> Most of the varieties were obtained originally from J. H. Martin, Office of Cereal Crops and Diseases, U. S. Dept. of Agr., and a few were obtained from A. C. Arny, Division of Agronomy and Plant Genetics, University Farm. The crosses, Marquis x Preston, etc., listed in Table III, were furnished by Dr. Hayes, Division of Agronomy and Plant Genetics. These were made by Dr. Hayes in 1915 with the hope of producing a variety of wheat more resistant to scab than Marquis, yet having the desirable agronomic characters of Marquis.

years, and a few for nine years. Fifty of the varieties were tested also at the branch experiment station at Waseca,<sup>2</sup> for two years. Varieties and selections grown for at least three years and a few newly developed varieties resistant to stem rust grown for one year only are included in the tabulated results (Tables I, II, III, and IV).

In 1925, the varieties listed in Table I were grown in single rows, in 1926 a second planting of the same varieties was made about two weeks later than the first, and in 1927 they were grown in uniformly replicated rows. The varieties listed in Table III were grown in duplicate plots at University Farm, three 5-foot rows of each variety in a plot. At Waseca the same varieties were grown in replicated single rod rows. At University Farm the plants were artificially inoculated. They were sprayed with a suspension of spores of *Fusarium spp.* at intervals of a day or two from the time of heading until the semi-hard-dough stage. When the weather was especially dry the plants were sprayed late at night. Most of the inoculum was obtained from material collected at different places in Minnesota, but some was obtained from other states. The pathogene was isolated from some of the collections and grown on potato dextrose agar or on a mixture of autoclaved wheat and oats. Some inoculum was obtained by making washings of diseased spikelets of wheat gathered the previous season. No attempt was made to use only one species or strain of the scab-producing organisms, because it was hoped to determine the reaction of the varieties to as many as possible. The plants at Waseca were not inoculated artificially.

Counts to determine the percentage of affected heads were made shortly before the wheat ripened. The percentage was usually based on counts of 200 heads (Table III), but in some cases (Tables I and II) it was based on a smaller number, particularly when the varieties were severely affected. The percentage of infected seed was determined by examination of scabby heads in the laboratory.

## RESULTS

All of the 350 varieties and selections of *Triticum vulgare*, *T. durum*, *T. compactum*, *T. dicoccum*, *T. turgidum*, *T. spelta*, and *T. polonicum* became infected to a greater or less degree. None were immune. At least some varieties within all these group species were susceptible. The percentage of infected heads in the different varieties ranged from a bare trace to 100.

It is evident from Tables I, II, and III that the common wheats as a class are more resistant than the durums, altho some of the common wheats are very susceptible. In 1927 the percentage of blighted

<sup>2</sup> The writers are indebted to R. E. Hodgson, Superintendent of the Southeast Experiment Station, for growing these varieties at Waseca.

heads in common wheats ranged from 1 to 78 and in 1928 from 6 to 93. The following were among the most susceptible: Chul, Bunyips, Emerald, Federation, Gypsum, and Propo. Marquis, the most popular variety in the hard red spring wheat region, and Marquillo, a promising rust-resistant variety, were susceptible. The following were very resistant: Converse, Glyndon Fife, Haynes Bluestem, Huston, Jumbuck, Lodoga, Norka, Rysting, Wellman, and White Fife.

The average percentage of infected heads of Glyndon Fife during seven seasons (Table II) was 4.0 in contrast with 26.7 of Kitchener and 22.1 of Marquis. Kota was intermediate, the infection being 17.4 per cent for the same period (see Fig. 1).

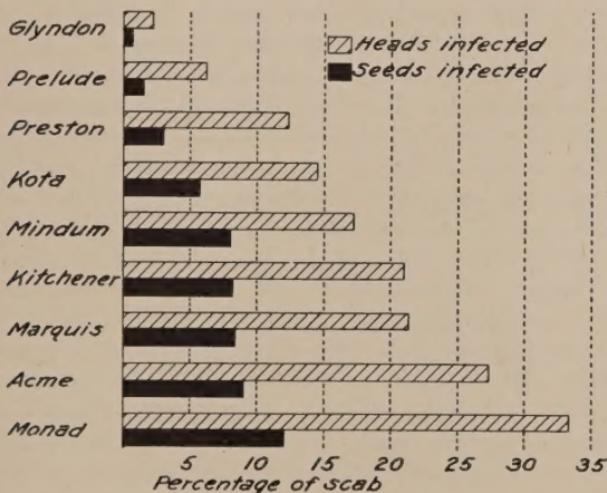


Fig. 1. Average Percentages of Fusarial Head and Seed Blight on Nine Varieties of Wheat Artificially Inoculated at University Farm 1921-23 and 1925-27 Inclusive

The durum wheats as a class were decidedly more susceptible than the common wheats. In 1927 the percentage of infection on different varieties of durum ranged from 1 to 100, altho most of the more than 200 varieties tested from 1925 to 1928 were susceptible. Some of the most susceptible were Adjini, Negro, Potia Nadiad, and Souri. The following were resistant: Batum, Medeah, and C. I. 3198. Mindum, Minn. 470, appears to be the most resistant of the durum varieties commonly grown in Minnesota and the Dakotas. The average percentage of infected heads in this variety for seven years was 25.0 as compared with 40.1 for Monad and 36.3 for Acme (See Table II).

There were differences also in the susceptibility of strains within a variety. For example, four selections of Kubanka, C. I. 1440, differed considerably in this respect. The average for infected seed

of one selection of this variety for 1926 and 1927 was 7.7 per cent, while that of another selection was 28.7 per cent for the same two-year period (Table I).

An attempt was made to determine the behavior of crosses between susceptible and resistant parents. In Table III is summarized the behavior of 38 hybrids. These crosses were tested at Waseca from 1923 to 1925 inclusive, and at University Farm from 1923 to 1927 inclusive. In 1924 no notes were taken at either place because little scab developed, and there was a severe epidemic of head blight caused by other factors than scab. Some hybrids were resistant at both Waseca and University Farm, others were susceptible at both places, while still others were susceptible at one place but resistant at the other. Most of the crosses were intermediate in their reaction to scab, altho some of the lines obtained from Marquis x Preston crosses and some from Marquis x Haynes Bluestem crosses were as resistant as the resistant parent. The Preston parent used in the Preston x Marquis crosses was not Preston, Minn. 924, but a selection from it. Its reaction to scab, according to a preliminary test, was apparently identical with that of Preston, Minn. 924. These hybrids were purified strains; the original crosses were made by Dr. H. K. Hayes in 1915.

Eight rust-resistant varieties of wheat, developed from crosses between Kota and Marquis, were tested in 1928. All were very susceptible to Fusarial head blight. The percentage of infection ranged from 44.5 to 88.5, while in Marquis it was 28.3 and in Kota 34.0.

The writers observed no gross morphological characters within any class of wheat that could be correlated with resistance or susceptibility. Schmitz (14) concluded that awnless varieties of common wheats were more susceptible than awned varieties and that pubescent varieties were the most susceptible of all. The writers found no apparent correlation between reaction to head blight and pubescence and the presence or absence of awns. Nearly all the durums tested were awned, and, as previously stated, they were very susceptible as a class. Selections within a variety that do not differ greatly in morphological characters often react differently toward scab, thus supporting the observation that there is no obvious correlation between reaction to scab and morphological characters. Furthermore, some of the susceptible lines from Marquis x Haynes Bluestem crosses resembled the susceptible parent in morphology, while others resembled the resistant parent. This was true also of selections from the Marquis x Preston cross.

It is evident from Tables I, II, and III that there are marked differences in the degree of infection in the same varieties when grown the same year at Waseca and University Farm and also when

grown at the same place in different years. Statistical studies were made to determine the degree of correlation between the percentages of infection of the same varieties grown at different places in the same year and in the same place in different years. All calculations were carried to four decimal places, and the number was then reduced to that suggested by Kelley (12). Results are given in Table IV. All the correlation coefficients given in the text are based on calculations in which the percentage of scab infections was carried to tenths of a per cent. The reaction of the varieties presented in Tables I, II, and III are given to only the nearest whole number.

The average percentages of infected seeds for the varieties tested at Waseca in 1923 and 1925 were 1.2 and 1.1 respectively. The correlation between the infections for these two years was  $+.65 \pm .06$  (Table IV). The average percentage of seed infection for the same varieties and strains at University Farm was 0.4 and 4.9 respectively. In this case the correlation coefficient was  $+.35 \pm .09$ . Apparently the conditions for infection were more nearly the same for the two years at Waseca than at University Farm. It is of considerable interest that a correlation coefficient of  $+.65 \pm .06$  was obtained, when the mean percentages of infected seeds were only 1.2 and 1.1 for the two years correlated. Apparently reaction to scab at Waseca was strongly inherited under the conditions of the experiment. The lower correlation at University Farm may be partly explained by the low percentage of infection in 1923—so low that it was difficult to determine statistically whether the varieties grown were really resistant or had merely escaped infection. A higher correlation was obtained between percentages of seed infection of the same strains at Waseca and University Farm in 1925 than in 1923, as shown by the correlation coefficients of  $+.59 \pm .04$  and  $+.42 \pm .08$  respectively.

At University Farm in 1925 and 1926 the average percentages of infected heads were 29.6 and 8.2 respectively, while the average percentages of infected seeds were 7.4 and 3.1 for the same varieties. The correlation coefficient for seed infection was  $+.22 \pm .10$  and for head infection  $+.15 \pm .10$ . Neither can be considered statistically significant. The same strains and varieties were grown in two series in 1925, one series being planted two weeks later than the other. The average percentage of infected heads for the first series was 29.6 and for the second 5.1. The correlation for percentage of heads infected in the two plantings was  $+.19 \pm .10$ . The average percentages of infected seeds in the same varieties were 7.2 and 2.2 respectively, and a correlation coefficient of  $+.38 \pm .09$  was obtained for the two plantings. Apparently time of planting has a very marked effect on the reaction of varieties to scab infection. From 1925 to 1927, inclusive, a much larger number of varieties were tested at University Farm. The

average percentage of heads infected for 71 varieties of vulgare wheats was 10.1 in 1926 and 15.7 in 1927; for the durum wheats it was 12.7 per cent and 52.4 per cent respectively, for the same two years. The average percentage of infected seeds for the same vulgare varieties was 4.4 in 1926 and 8.3 in 1927; for the durum varieties, 6.7 in 1926, and 30.3 in 1927. Correlation coefficients of  $+.02 \pm .08$ ,  $+.06 \pm .05$ ,  $+.06 \pm .05$ , and  $+.05 \pm .05$  (Table IV) were obtained for both head and seed infection when the reactions of these strains of wheat to scab in 1926 and 1927 were correlated. It is evident that there was no significant correlation between the percentages of infection in 1926 and 1927, when the percentage of either infected heads or infected seeds was considered.

An attempt was made to determine whether there was a correlation between the severity of head blight and the percentage of seeds infected. The results are summarized in Tables V, VI, and VII. The correlation between two series, A and B, of 116 varieties of durum planted at the same time was essentially the same whether the percentages of infected heads or of seeds were used in calculating the correlation coefficient. They were respectively  $+.66 \pm .04$  and  $+.62 \pm .04$ . There was a correlation of  $+.91 \pm .02$  between the average percentage of heads infected and the average percentage of seeds infected in 41 varieties grown at Waseca in 1926 and 1927. In a similar study of the 41 strains grown for three years and for 71 vulgare and 154 durum varieties grown for two years at University Farm, correlation coefficients of  $+.87 \pm .03$ ,  $+.92 \pm .01$ , and  $+.86 \pm .01$  were obtained. Further, there was a correlation of  $+.87 \pm .01$  between the average percentage of heads infected and of seeds infected in the 116 varieties of durum wheat grown in two systematically distributed plots at University Farm in 1927. Blakeman's test was applied to each of these correlations, and regression was found to be essentially linear.

One of the primary purposes of this study was to determine the extent of inheritance of reaction of wheat varieties to scab infection. In the studies reported here no significant difference could be demonstrated between correlation coefficients obtained from heads infected and seeds infected in the same varieties and lines grown from year to year or in different series grown in the same year. The correlation coefficient of  $+.65 \pm .06$ , obtained from the percentage of seeds infected in the same 41 strains grown in 1923 and 1925 at Waseca, and of  $+.35 \pm .09$  obtained when the same varieties were grown at University Farm in those years, indicates that in these cases the factors for inheritance apparently played a far more important part in determining reaction at Waseca than at University Farm.

No significant correlation coefficients were found between reactions of either vulgare or durum varieties grown at University Farm in

1925 and 1926 or in 1926 and 1927. Apparently conditions for infection of these varieties in 1925 and 1926 or in 1926 and 1927 were quite different.

From the correlation of  $+.87 \pm 0.2$  between the average percentages of head infection and seed infection in 116 durum wheat varieties grown in two plots the same year, the percentage of seeds infected in a given variety can be predicted with considerable accuracy if the percentage of infected heads is known. (In this case the percentage of seeds infected ranged from 3 to 87.) For practical purposes, in view of the much greater ease with which notes may be taken on heads infected, and the fact that all correlation coefficients determined between percentages of heads and seeds blighted were at least  $+.86$ , it seems fair to conclude that data on head infection in Minnesota may replace notes on seed infection.

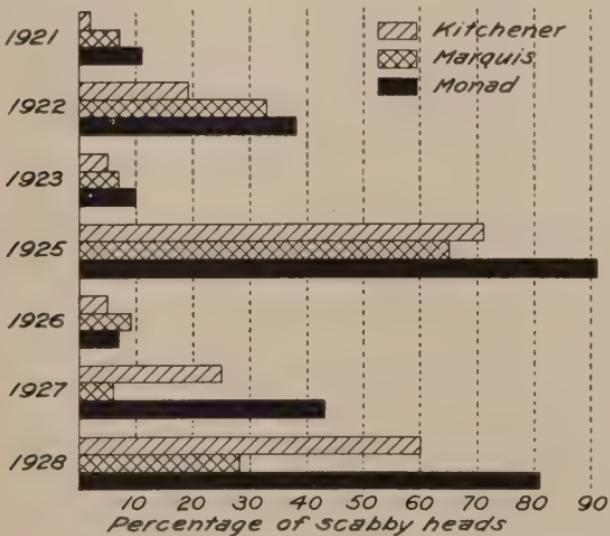


Fig. 2. Fluctuation in the Development of Fusarial Head Blight on Three Varieties of Wheat Artificially Inoculated at University Farm 1921-23 and 1925-28 Inclusive

The degree of scab infection in the same varieties may vary greatly from season to season (see Fig. 2). In 1926, at University Farm, the percentages of infected heads were 3.3 for the durum variety Sineuska, C. I. 4010; and 1.0 for Kubanka 8, C. I. 4063; but in 1927 they were 100 and 57.8 respectively. On the other hand, Reward, John Brown, and Marquillo were much more severely infected in 1926 than in 1927 (Table I). Preston was resistant four years out of seven and Monad fairly susceptible five years out of seven at University Farm (Table II). It is evident from the low and statistically nonsignificant

correlation coefficients obtained in these studies that several variables strongly influence the percentage of infection. It seems probable that these variables may be meteorological conditions and the prevalence of different species or physiologic forms of the pathogens.

Head blight of wheat may be caused by several species of *Fusarium*. Atanasoff (4) lists 7 species that may cause head blight and several others that may cause root rot, and points out that the different ones may have different geographic distribution. For example, *Gibberella saubinetii* (Mont.) Sacc. commonly causes scab in the United States, Bulgaria, and Southern Russia; *F. avenaceum* (Fr.) Sacc. commonly causes scab in Northern Russia. Atanasoff concluded that approximately 50 per cent of the head blight in Holland was caused by *F. culmorum* (W. G. Sm.) Sacc., altho he found *G. saubinetii* also on about 40 per cent of the infected heads. Both species were common in Germany, where *Calonectria graminicola* (Berk. & Brm.) Wr. is said to cause a considerable amount of Fusarial head blight of wheat. Dickson, Johann, and Wineland (8) concluded that 94 to 98 per cent of the head blight of wheat in the central and eastern states of the United States was caused by *G. saubinetii*. Preliminary studies by Tu (18) indicate that this is not always true for Minnesota. In 1926 he repeatedly isolated several pathogenic species of *Fusarium* from scabby wheat. It seems clear, therefore, that several species of *Fusarium* may cause head blight of wheat. Furthermore, as shown by Tu (18), there are striking differences in the temperature requirements of some of these species. Obviously, then, considerable variation in the degree of infection of varieties in different seasons and different localities may be expected.

Not only do different species of *Fusarium* cause head blight and seed blight, but there is evidence of physiologic specialization within some of these species. Greaney and Bailey (9) found at least four different cultural forms of *G. saubinetii*. Two of these were virulent pathogens; the others were much less virulent. Tu (18) was able to distinguish three physiologic forms of *F. culmorum* by their cultural characters and parasitic effect on heads of wheat and barley. It seems likely that there are many physiologic forms of several of the species of *Fusarium* which cause head blight and seed blight. This fact would partially explain the variability in the apparent resistance of varieties at different times and in different places.

Not only are there physiologic forms of some of the wheat scab pathogens, but it is likely that new ones are being produced. Physiologic forms of some fungi have been shown to mutate frequently. For example, mutation occurs very commonly in the smut fungi, particularly *Ustilago zeae* (Beck.) Ung. (16) and some of the Fungi Imperfecti such as *Helminthosporium sativum* P., K. and B. (6). Brown

(5) has shown that mutation is fairly common in certain species of *Fusarium*. Recently Tu (18) observed mutation in *F. culmorum*, a virulent pathogene on wheat and barley in Minnesota. It seems likely, then, that the virulence of physiologic forms of various species of *Fusarium* may be changing considerably as a result of mutation.

Meteorological conditions also constitute an important variable that probably accounts for some differences in behavior of varieties with respect to scab. For example, Marquis wheat becomes heavily infected with scab in many years in southern Minnesota. At St. Paul, however, one may spray this variety repeatedly with a suspension of conidia of various scab organisms and yet in certain years little infection results. In the northwestern section of the state there seldom is more than a bare trace of Fusarial head blight. This may be due partly to the fact that relatively little corn is grown in that region. On the other hand, precipitation and temperature are quite different in northwestern and in southern Minnesota. The effect of meteorological conditions on the development of scab is shown further by experiments made for four years at University Farm. The same varieties of wheat were grown on uniform land but were sown at different dates (Table VIII). In 1923, for example, the average percentage of head infection for 52 varieties sown on April 27 was 4.9 and for the same varieties sown a week later it was 3.1, and there was almost no scab when these varieties were sown two weeks later. In 1925 and 1926 there was the same general ratio between the percentages of infected heads in the plots sown at different dates, altho the percentages of infection were higher than in 1923. In 1927, however, conditions were reversed. There were 5.7 per cent of blighted heads in Marquis and 4.3 per cent in Monad sown on April 29. But in Marquis and Monad sown on May 6 infection was 100 per cent. When sown one week later, May 13, the two varieties were still severely infected, the percentages being 86.7 and 96.5 respectively. In 1925, on the other hand, only 1.5 and 0.5 per cent of the heads were infected in Marquis and Monad sown on May 6. The same general relationship held for percentages of infected seed.

Rainfall appears to be one of the most important meteorological factors influencing the degree of infection. This is borne out by numerous field observations made by the writers and other investigators. Atanasoff (4), Scott (15), and others have concluded that an abundance of moisture is conducive to Fusarial head and seed blight. It has been supposed that rainfall is most effective in promoting infection when it falls at flowering time or shortly thereafter. According to Dickson, Johann, and Wineland (8), initial infection occurs principally through the anthers of the stamens. Adams (1) found the first evidence of infection in the developing embryo. Atanasoff (4) maintains that

infection may take place as readily soon after the disappearance of the anthers as earlier. In his experiments, infection resulted from artificial inoculations made at any time from flowering until the medium-dough stage, altho he concluded that the host was most susceptible at flowering time and shortly thereafter. He is of the opinion that infection does not necessarily take place through anthers but may take place at any point on the spikelets where suitable contact can be made between the pathogene and the host. It seems likely, therefore, that abundant rainfall from blossoming time until the dough stage would be conducive to the development of scab.

Weather conditions also influence the progress of the disease after the infection has taken place. The pathogene usually spreads rapidly when a few hot rainy days follow the flowering period of wheat, and symptoms of the disease appear within a few days. If conditions remain favorable for the development of the pathogene, it may extend 5 or 10 cm. and sometimes farther down the stem of the infected plant. Consequently the heads often ripen prematurely. Even under favorable conditions, the rate of spread of the pathogene and the symptoms differ in different varieties. The discoloration of the peduncle may be gray in some varieties, brownish in others, and creosote-like in still others. Fairly high humidity is essential for the production of conidia on infected plant parts. Severe infection, however, may occur without any conspicuous signs of sporulation. Sporulation usually is not abundant on infected varieties at University Farm.

There is always a possibility that varieties may escape infection. This undoubtedly is true of some of the varieties grown in 1925, 1926, and 1927. In 1927, for example, most of the early maturing varieties were relatively free from infection, altho they had been heavily infected the previous season. This was true particularly of Reward, Red Sask., and Quality (Table I). Arthur (2) found that head blight was more severe on late-maturing than on early-maturing varieties, and that delayed maturity of early varieties resulted in heavy infection. This may be true for certain varieties and certain regions, but it is not universally true. The durum wheats as a class mature later than the common wheats and are more susceptible to scab, but resistance within the durum class is not correlated with the time of heading or with the date of maturity. The same is true of the common wheats.

## SUMMARY

1. During the last nine years more than 350 spring varieties, selections, and hybrids of *Triticum spp.* have been tested for relative susceptibility to Fusarial head and seed blight at University Farm, St. Paul, Minnesota. Fifty of these varieties were tested at Waseca, Minnesota, also.

2. All of the 350 varieties, selections, and hybrids became infected to a greater or less degree..

3. The common wheats were more resistant than the durums, altho some were very susceptible. There was considerable variation in resistance to scab in the durums also.

4. A study was made of the behavior of crosses between susceptible and resistant parents at University Farm, St. Paul, and at Waseca, Minnesota. Most of the hybrids from Marquis x Preston and from Marquis x Haynes Bluestem were intermediate in their reaction to scab. Some of the lines were as resistant as the resistant parent. All the Kota x Marquis crosses studied were susceptible.

5. No apparent gross morphological characters within any class of wheat appeared to be highly correlated with resistance or susceptibility.

6. No statistically significant differences could be demonstrated between correlation coefficients obtained from heads infected and seeds blighted in the same varieties and lines grown in different years, or in two different series in the same year. The correlations between the percentages of heads blighted or seeds blighted in the same varieties ranged from  $+.86 \pm .01$  to  $+.92 \pm .01$ . Therefore it seems fair to conclude that, for practical purposes, data on head infection may be used to replace notes on seed infection in Minnesota.

7. It was evident from the very low and statistically nonsignificant correlation coefficients obtained between the percentages of infection in varieties grown in the same year but sown at different times, or grown at the same place in different years, or at different places in the same year, that a number of variables strongly influenced the percentages of infection. These variables were probably differences in meteorological conditions and in the prevalence of different species and physiologic forms of the pathogens.

8. Considerable caution is necessary in drawing conclusions from the results of varietal tests unless they are conducted for several years under carefully replicated and controlled conditions.

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TABLE I

PERCENTAGE OF FUSARIAL HEAD AND SEED BLIGHT ON WHEAT VARIETIES INOCULATED  
ARTIFICIALLY IN THE FIELD AT UNIVERSITY FARM, ST. PAUL,  
MINNESOTA, 1925-27 INCLUSIVE

Species and varieties	C. I. No.	Degree of infection, 1925	Percentage of heads infected*			Percentage of seeds infected		
			1926	1927	Av.	1926	1927	Av.
<i>Triticum vulgare</i>								
Baart .....	1697	T†	5	19	12.0	1	9	5.0
Bobs .....	4991	M	20	14	17.0	7	4	5.5
Bunyip .....	5125	H	27	30	29.5	11	16	18.5
Canadian Red .....	6282	..	24	39	31.5	13	16	14.5
Ceres .....	6900	..	20	17	18.5	9	5	7.0
Champlain .....	4782	M	3	23	13.0	2	8	5.0
Chul .....	2227	H	57	..	..	33	..	..
Colorado No. 50 ..	4959	..	12	14	13.0	8	6	7.0
Converse .....	4141	M	1	2	1.5	T	T	T
Defiance .....	6477	M	1	18	9.5	1	13	7.0
Dicklow .....	3663	M	9	28	18.5	3	22	12.5
Early Defiance .....	6480	M	15	5	10.0	5	1	3.0
Early Red Fife .....	4932	H	5	11	8.0	2	6	4.0
Emerald .....	4397	T	4	55	29.5	1	24	12.5
Erivan .....	2397	..	11	3	7.0	2	1	1.5
Federation .....	4734	H	6	78	42.0	2	56	29.0
Foisy .....	5242	M	0	15	7.5	0	7	3.5
Galgalos .....	2398	..	4	32	18.0	2	17	9.5
Ghirka .....	1517	T	18	5	11.5	9	2	5.5
Glyndon .....	2870	L	0	5	2.5	0	1	0.5
Gypsum .....	4762	M	23	57	40.0	14	37	25.5
Hard Federation ...	4980	M	14	21	17.5	8	11	9.5
Haynes Bluestem .....	2874	T	0	2	1.0	0	2	1.0
Humpback .....	3690	M	0	31	15.5	0	19	9.5
Huron .....	3315	..	2	3	2.5	T	1.0	0.5
Huston .....	5208	T	6	1	3.5	3	1.0	2.0
Indian .....	4489	H	1	21	11.0	1	10.0	5.5
Java .....	4966	..	13	3	8.0	5	2.0	3.5
John Brown .....	2397	..	33	1	17.0	14	1.0	7.5
Jumbuck .....	4608	T—	1	1	1.0	1	1.0	1.0
Kitchener .....	4800	H	5	25	15.0	2	10.4	6.0
Kota .....	5878	T	6	4	5.0	2	2.0	2.0
Ladoga .....	4795	..	1	2	1.5	T	1.0	0.5
Laramie .....	6235	..	1	5	3.0	T	4.0	2.0
Lynn .....	6346	M	13	16	14.5	7	8.0	7.5
Marquis .....	3641	H	9	6	7.5	4	3.0	3.5
Marquis x Kanred, Minn. 2219 .....	....	..	2	15	8.5	T	6.0	3.0
Marquis x Kanred, Minn. 2223 .....	....	..	8	14	11.0	2	8.0	5.0
Marquis x Kanred, Minn. 2121 .....	....	..	16	21	18.5	4	5.0	4.5
Marquis x Kanred, Minn. 2220 .....	....	..	8	17	12.5	2	10.0	6.0
Marquis x Kota 1656 .....	....	..	19	11	15.0	8	6.0	7.0
Marquillo, Minn. 2202 .....	....	M	42	14	28.0	10	2.0	6.0
Mexican Bluestem .....	6004	H	4	46	25.0	2	16.0	9.0
New Zealand .....	6011	L	1	28	14.5	1	23.0	12.0
Norka .....	4377	M	2	1	1.5	T	T	T
Pacific Bluestem .....	4067	..	5	8	6.5	1	3.0	2.0
Palisade .....	4798	L	1	15	8.0	T	5.0	2.5

\* The percentages in the table for 1926 and 1927 were reduced to the nearest whole number. The correlation studies in the text are based on calculations in which the percentages were carried out to the nearest tenth.

† T = Trace, L = Light, M = Moderate, H = Heavy.

TABLE I—Continued

PERCENTAGE OF FUSARIAL HEAD AND SEED BLIGHT ON WHEAT VARIETIES INOCULATED  
ARTIFICIALLY IN THE FIELD AT UNIVERSITY FARM, ST. PAUL,  
MINNESOTA, 1925-27 INCLUSIVE

Species and varieties	C. I. No.	Degree of infection, 1925	Percentage of heads infected*			Percentage of seeds infected		
			1926	1927	Av.	1926	1927	Av.
<i>Parkers Marquis</i>								
Minn. 2222	....	..	17	6	11.5	1	4.0	2.5
Pioneer	4324	T—	6	2	4.0	2	2	2.0
Power	3697	L	1	5	3.0	1	3	2.0
Prelude	4323	..	7	8	7.5	3	3	3.0
Preston	3328	T	4	8	6.0	1	4	2.5
Progress, Minn. 2225	....	..	11	4	7.5	3	1	2.0
Propo	1970	T	1	68	34.5	1	37	18.0
Quality	6157	M	20	6	13.0	3	3	3.0
Red Bobs	6255	H	36	17	26.5	23	9	16.0
Red Fife	3329	H	4	7	5.5	1	2	1.5
Red Sask., Minn. 2193	....	..	23	4	13.5	7	2	4.5
Reseca	6390	M	0	9	4.5	0	5	2.5
Reward, Minn. 2204	....	..	34	0	17.0	10	0	5.0
Rink	5868	H	0	17	8.5	0	13	6.5
Ruby	6047	..	14	2	8.0	6	1	3.5
Rysting	3022	L	1	3	2.0	T	1	0.5
Sonora	3036	M	5	31	18.0	4	20	12.0
Stanley	4796	M	10	4	7.0	3	1	2.0
Surprise	2986	M	13	8	10.5	6	6	6.0
Touse	6047	H	1	26	13.5	1	17	9.0
Webster	3780	..	23	58	40.5	9	26	17.5
Wellman	4144	M	0	3	1.5	0	1	0.5
White Federation	4981	M	35	4	19.5	19	2	10.5
White Fife	4412	L	0	5	2.5	0	3	1.5
<i>Triticum durum</i>								
Abl-el-Kodar	2075	M	2	65	33.5	1	41	24.0
Acme	5284	..	6	35	20.5	5	20	12.5
Adkini	1594	..	10	55	32.5	6	28	17.0
Adjini	4594	H	15	93	54.0	12	47	29.5
Agini	3844	H	14	71	42.5	9	36	22.5
Akrona	6881	M	7	35	21.0	2	24	13.0
Albacete	2091	..	2	28	15.0	1	11	6.0
Allemond	4595	T—	13	67	40.0	11	43	27.0
Anchuelo	3280	H	3	32	17.5	3	28	15.5
Arnautka	1493	M	7	16	11.5	3	11	7.0
Arnautka	1431	M	4	23	13.5	3	11	7.0
Arnautka	1537	H	25	71	48.0	14	36	25.0
Arnautka	1494	..	1	19	10.0	1	10	5.5
Azizi	4593	H	5	24	14.5	2	16	9.0
Bansi	4560	M	12	78	45.0	8	40	24.0
Batum	3096	T—	1	16	8.5	0	2	1.0
Berbern	4596	M	9	77	43.0	6	39	18.0
Beliouni	3848	M	17	66	41.5	10	34	22.0
Beliouni	3852	M	9	85	46.5	7	74	40.5
Beliouni	3842	M	0	76	38.0	0	60	30.0
Beloturka	1520	M	8	60	34.0	3	29	16.0
Bengal	5060	..	25	53	39.0	9	19	14.0
Biskra	4582	M	11	36	23.5	8	27	17.5
Black Don	1446	M	22	65	43.5	T	16	8.0
Blanca	2192	T—	16	91	53.5	5	71	38.0
Blue Beard	6128	M	0	93	46.5	0	80	40.0
Buford	5295	M	0	27	13.5	0	11	5.5
Cowra No. 16	4738	H	4	78	41.0	3	68	35.5
D-46	....	M	35	51	43.0	17	25	21.0
Deves	5476	H	17	49	33.0	6	28	17.0
Durum No. 7	3323	..	20	66	43.0	8	23	15.5

TABLE I—Continued

PERCENTAGE OF FUSARIAL HEAD AND SEED BLIGHT ON WHEAT VARIETIES INOCULATED ARTIFICIALLY IN THE FIELD AT UNIVERSITY FARM, ST. PAUL,  
MINNESOTA, 1925-27 INCLUSIVE

Species and varieties	C. I. No.	Degree of infection, 1925	Percentage of heads infected*			Percentage of seeds infected		
			1926	1927	Av.	1926	1927	Av.
Durum No. 4 .....	3321	M	12	81	46.5	10	56	33.0
Gharnovka .....	1447	M	38	87	62.5	21	43	31.5
Golden Ball .....	5059	..	0	89	44.5	0	57	28.5
Iumillo .....	1736	M	4	45	24.5	2	17	9.5
Kahla .....	2088	M	5	24	14.5	2	13	7.5
Kahla .....	5529	..	2	35	18.5	1	11	6.0
Kubanka .....	1440	M	1	52	26.5	1	26	13.5
Kubanka .....	1440-74	M	2	65	33.5	T	57	28.5
Kubanka .....	1440-94	..	4	61	32.5	3	36	19.5
Kubanka .....	1440-99	M	20	70	45.0	9	54	31.5
Kubanka .....	1440-117	..	2	39	20.5	T	15	7.5
Kubanka .....	1516	H	19	37	23.0	11	26	18.5
Kubanka .....	1581	M	10	67	38.5	7	28	17.5
Kubanka .....	3715	M	4	88	46.0	1	68	34.5
Kubanka No. 8 .....	4063	M	1	58	29.5	1	23	12.0
Lenah Khetifa .....	4585	..	4	22	13.0	2	9	5.5
Mahmoudi .....	4591	H	5	57	31.0	3	35	19.0
Mahmoudi Ag. 3 ..	4592	H	13	92	52.5	7	61	34.0
Mekki .....	4590	M	18	68	43.0	11	32	21.5
Marouani .....	1593	M	4	63	33.5	3	24	13.5
Marouani .....	2235	M	14	26	20.0	6	11	8.5
Marouani .....	5473	M	12	52	32.0	5	20	12.5
Medeah .....	4185	T	6	50	28.0	2	39	20.5
Medeah .....	4581	M	8	7	7.5	6	3	4.5
Mindum .....	5296	M	5	16	10.5	2	6	4.0
Monad .....	3320	..	3	43	23.0	2	32	17.0
Mohamed ben Bachir	2087	M	3	80	41.5	2	66	34.0
Namira .....	4583	M	20	16	18.0	5	7	6.0
Negro .....	2000	M	22	97	59.5	13	37	25.0
Nodak .....	6519	..	2	40	21.0	2	16	9.5
Peliss .....	1584	..	12	60	36.0	4	39	21.5
Pererodka .....	1515	M	11	80	45.5	8	43	25.5
Potia Nadiad .....	4601	..	20	100	60.0	20	50	35.0
Richi .....	2080	M	2	87	44.5	1	68	34.5
Saragolla .....	2228	H	13	50	31.5	10	29	19.5
Sbei .....	4586	M	5	20	12.5	4	7	5.5
Sineuska .....	4010	H	3	100	51.5	1	89	45.0
Souri .....	4597	M	50	87	68.5	36	50	43.0
Taganrock .....	4589	T	0	35	17.5	0	23	11.5
Taganrock .....	3979	M	5	95	50.0	4	49	26.5
Teiskais .....	3266	M	9	85	47.0	2	67	34.5
Theuniseen .....	4184	..	3	32	17.0	1	12	6.5
White Spring .....	3099	M	11	82	46.5	4	41	22.5
Yellow Gharnovka	1444	M	27	46	36.5	20	26	23.0
Yellow Gharnovka	2006	M	4	55	29.5	2	27	14.5
Velvet Don .....	2122	M	20	68	44.0	7	41	24.0
Unnamed varieties								
	2691	M	10	15	12.5	6	7	6.5
	3069	M	31	31	31.0	7	12	9.5
	3137	M	0	78	38.5	0	65	32.5
	3138	T	0	86	43.0	0	50	25.0
	3139	H	9	74	41.5	3	32	17.5
	3141	M	0	94	46.5	0	66	33.0
	3143	M	0	38	19.0	0	14	7.0
	3144	T	14	38	26.0	9	6	7.5
	3146	M	21	93	57.0	13	52	32.5
	3147	T	6	73	39.5	5	66	35.5
	3148	T	10	27	18.5	7	13	10.0

TABLE I—Continued

PERCENTAGE OF FUSARIAL HEAD AND SEED BLIGHT ON WHEAT VARIETIES INOCULATED  
ARTIFICIALLY IN THE FIELD AT UNIVERSITY FARM, ST. PAUL,  
MINNESOTA, 1925-27 INCLUSIVE

Species and varieties	C. I. No.	Degree of infection, 1925	Percentage of heads infected*			Percentage of seeds infected		
			1926	1927	Av.	1926	1927	Av.
Unnamed varieties	3156	M	14	71	42.5	7	52	29.5
	3161	H	4	42	22.0	3	29	16.0
	3162	M	47	19	33.0	16	9	12.5
	3163	H	12	49	30.5	3	22	12.5
	3166	T	35	21	28.0	8	6	7.0
	3169	M	4	77	40.5	4	27	15.5
	3170	..	21	27	24.0	14	14	14.0
	3172	T	0	19	9.5	0	10	5.0
	3173	M	9	44	26.5	3	19	11.0
	3175	H	5	77	41.0	3	45	24.0
	3176	H	2	90	46.0	1	51	26.0
	3177	M	25	19	22.0	12	9	10.5
	3179	T+	3	23	13.0	0	11	5.5
	3181	H	1	44	22.5	T	16	8.0
	3184	M	4	72	38.0	1	59	30.0
	3187	M	46	22	34.0	25	7	16.0
	3190	H	0	34	17.0	0	14	7.0
	3191	M	42	50	46.0	22	17	19.5
	3192	M	5	12	8.5	5	3	4.0
	3193	M	3	1	2.0	1	T	0.5
	3195	M	4	16	10.0	1	5	3.0
	3196	M	4	27	15.5	1	14	7.5
	3197	M	0	17	8.5	0	9	4.5
	3198	M	4	3	3.5	2	1	1.5
	3199	H	2	15	8.5	T	7	3.5
	3200	H	0	18	9.0	0	10	5.0
	3207	M	1	54	27.5	T	34	17.0
	3224	H	2	10	6.0	2	6	4.0
	3226	M	22	7	14.5	8	2	5.0
	3230	H	3	28	15.5	1	10	5.5
	3231	H	6	37	21.5	4	23	13.5
	3233	H	6	50	28.0	2	32	17.0
	3234	M	1	52	26.5	T	49	24.5
	3235	M	2	26	14.0	T	20	10.0
	3236	H	0	53	26.5	0	31	15.5
	3237	H	4	90	47.0	3	47	25.0
	3238	H	20	23	21.5	6	7	6.5
	3241	H	5	68	36.5	2	32	17.0
	3242	M	14	16	15.0	1	8	4.5
	3243	M	38	75	56.5	24	58	41.0
	3244	M	18	63	40.5	6	33	19.5
	3265	M	28	46	37.0	10	28	19.0
	4074	..	11	93	52.0	11	68	39.5
	4076	M	18	70	44.0	13	44	28.5
	4526	..	28	12	20.0	16	7	11.5
	4544	M	0	81	40.5	0	49	24.5
	4917	M	27	60	43.5	12	34	23.0
	4918	..	16	26	21.0	8	8	8.0
	4919	M	29	95	62.0	26	42	34.0
	4925	M	30	48	39.0	20	32	26.0
	5094	M	3	13	8.0	2	5	3.5
	5111	..	61	32	46.5	30	8	19.0
	5112	M	0	96	48.0	0	64	32.0
	5477	M	0	76	38.0	0	61	30.5
	6130	M	11	23	17.0	6	12	9.0
<i>Triticum dicoccum</i>								
Vernal .....	1524	..	0	31	15.5	0	9	4.5
<i>Triticum polonicum</i>								
White, Polish ....	3007	T	0	93	46.5	0	63	31.5

TABLE II

PERCENTAGES OF FUSARIAL HEAD BLIGHT ON NINE VARIETIES OF WHEAT ARTIFICIALLY  
INOCULATED IN THE FIELD AT UNIVERSITY FARM, ST. PAUL, MINNESOTA,  
1921-23 INCLUSIVE, AND 1925-28 INCLUSIVE

Species, variety, and number	Percentage heads infected							
	1921	1922	1923	1925	1926	1927	1928	Av.
<i>Triticum vulgare</i>								
Glyndon Fife, Minn. 163 .....	1	2	0	9	0	5	11	4.0
Kitchener, Minn. 2153 .....	2	19	5	71	5	25	60	26.7
Kota, Minn. 2151 .....	2	4	4	69	6	3	34	17.4
Marquis, Minn. 1239 .....	7	33	7	65	9	6	28	22.1
Prelude, C. I. 4323 .....	3	8	4	12	7	2	41	11.0
Prston, Minn. 924 .....	T	7	3	44	4	17	6	11.6
<i>Triticum durum</i>								
Acme, Minn. 1967 .....	8	32	4	76	9	35	90	36.3
Mindum, Minn. 470 .....	12	26	3	33	12	16	73	25.0
Monad, Minn. 2156 .....	11	38	10	91	7	43	81	40.1

TABLE III

PERCENTAGES OF FUSARIAL HEAD AND SEED BLIGHT ON WHEAT VARIETIES AND HYBRIDS AT  
WASECA IN 1923 AND 1925, AND AT UNIVERSITY FARM IN 1923, 1925, AND 1926

Hybrid or variety and number	Percentage of heads infected*				Percentage of seeds infected			
	Waseca '23 '25 Av.	University Farm '23 '25 '26 Av.	Waseca '23 '25 Av.	University Farm '23 '25 '26 Av.	Waseca '23 '25 Av.	University Farm '23 '25 '26 Av.	Waseca '23 '25 Av.	University Farm '23 '25 '26 Av.
<i>Hybrids</i>								
Marquis x Preston II-15-3†	9 7 8.0	3 22 12 12.3	1 1 1.0	T 7 5 4.0				
II-15-5 18 11 14.5	6 35 20 20.3	2 3 2.5	1 10 7 6.0					
II-15-6 16 8 12.0	11 35 13 19.6	2 2 2.0	1 8 4 4.3					
II-15-7 15 14 14.5	4 29 9 14.0	2 4 3.0	T 4 5 3.0					
II-15-8 16 5 10.5	6 18 15 13.0	1 1 1.0	1 2 6 3.0					
II-15-10 12 5 8.5	8 .. 17 ..	1 2 1.5	1 .. 11 ..					
II-15-11 9 2 5.5	2 15 7 8.0	1 1 1.0	T 3 3 2.0					
II-15-13 12 7 9.5	3 16 25 14.6	1 2 1.5	T 3 10 4.3					
II-15-16 13 4 8.5	6 28 20 18.0	1 1 1.0	1 5 7 4.3					
II-15-17 15 3 9.0	2 10 7 6.3	2 1 1.5	T 2 3 1.5					
II-15-19 13 8 10.5	6 33 15 18.0	1 1 1.0	T 6 6 4.0					
II-15-20 12 6 9.0	5 12 3 6.6	1 1 1.0	1 2 1 1.3					
II-15-21 7 6 6.5	4 35 9 16.0	1 1 1.0	T 4 3 2.3					
II-15-22 15 3 9.0	3 21 4 9.3	1 1 1.0	T 3 1 1.3					
II-15-23 8 2 5.0	2 13 1 5.3	1 1 1.0	T 2 2 0.7					
II-15-24 7 6 6.5	3 17 1 7.0	1 1 1.0	T 4 4 1.3					
II-15-25 6 3 4.5	1 11 5 5.6	1 T 1.0	0 1 2 1.0					
II-15-26 10 7 8.5	4 41 12 19.0	1 2 1.5	1 8 4 4.3					
II-15-28 15 3 9.0	2 8 4 4.6	2 1 1.5	T 1 1 0.7					
II-15-29 18 9 13.5	3 42 7 17.3	2 1 1.5	T 7 3 3.3					
<i>Marquis x Haynes</i>								
Bluestem								
II-15-31 5 2 3.5	0 6 1 2.3	0 1 0.5	0 T T T					
II-15-32 10 2 6.0	2 6 4 4.0	1 T 0.5	T 2 1 1.0					
II-15-34 11 1 6.0	2 27 7 12.0	1 T 0.5	T 5 1 2.0					
II-15-36 4 2 3.0	0 12 1 4.3	T T T	0 2 1 1.0					
II-15-39 8 5 6.5	1 21 3 8.3	1 1 1.0	T 3 1 1.3					
II-15-40 7 1 4.0	4 27 1 10.6	1 T T	T 3 1 1.3					
II-15-41 16 3 9.5	1 19 1 7.0	2 1 1.5	T 3 T 1.0					
II-15-42 6 3 4.5	2 .. 3 ..	1 1 1.0	T .. 1 ..					
II-15-43 15 3 9.0	6 48 12 22.0	2 1 1.5	T 14 6 7.0					
Marquis x Iumillo								
II-15-44 13 3 8.0	5 24 9 12.6	1 1 1.0	1 10 3 4.6					
II-15-59 14 T 7.0	11 24 6 13.6	1 2 1.5	1 6 6 4.3					
II-15-51 20 2 11.0	7 13 17 12.3	2 1 1.5	1 4 8 4.3					
II-15-55 16 5 10.5	9 28 12 16.3	1 2 1.5	1 15 8 8.0					

TABLE III—Continued

PERCENTAGES OF FUSARIAL HEAD AND SEED BLIGHT ON WHEAT VARIETIES AND HYBRIDS AT WASECA IN 1923 AND 1925, AND AT UNIVERSITY FARM IN 1923, 1925, AND 1926

Hybrid or variety and number	Percentage of heads infected*			Percentage of seeds infected		
	Waseca		University Farm	Waseca		University Farm
	'23	'25	Av.	'23	'25	'26
Marquis x Kanred	II-18-8	9	7	8.0	4 34	4 14.0
	II-18-57	12	2	7.0	1 40	8 16.3
	II-18-58	12	2	7.0	1 74	4 26.3
	II-Bz-5	14	8	11.0	3 33	4 13.3
	II-B8-11	21	11	16.0	2 69	9 26.6
<i>Triticum vulgare</i>						
Glyndon Fife, Minn.	163	..	6	2	4.0	0 9
Haynes Bluestem, Minn.	169	..	1	1	1.0	1 ..
Kitchener, C. I.	2153	..	20	17	18.5	5 70
Kota, C. I.	5878	..	14	5	9.5	4 69
Kota x Marquis, N. D.	1656	..	5	5	..	69 ..
Marquis, Minn.	1239	..	16	15	15.5	7 65
Marquis x Kota, N. D.	1658	..	..	..	..	60 ..
Preston, Minn.	924	..	10	2	6.0	3 44
Prelude, C. I.	4323	..	..	1	..	4 12
Red Bobs, C. I.	2157	..	21	9	15	4 40
Ruby, C. I.	2153	..	5	4	4.5	3 18
<i>Triticum durum</i>						
Acme, C. I.	1967	..	34	11	22.5	4 76
Arnautka, C. I.	2103	..	10	5	7.5	4 15
Kubanka, C. I.	2194	..	26	15	20.5	5 46
Mindum, Minn.	470	..	8	4	6.0	3 33
Monad, C. I.	3320	..	23	17	20.0	12 10

\* The percentages in the table for '23, '25, and '26 were reduced to the nearest whole number while figures in the text are based on calculations in which the percentages were carried out to the nearest tenth.

† Nursery stock numbers.

TABLE IV

PERCENTAGES OF HEAD BLIGHT IN WHEAT VARIETIES AND HYBRIDS GROWN IN DUPLICATE SERIES AT UNIVERSITY FARM, ST. PAUL, MINNESOTA, IN 1928

Variety and number	Percentage of heads infected		
	Series A	Series B	Average
<i>Triticum vulgare</i>			
Bobs, C. I. 4991	63	95	79
Ceres 1658, Minn. 2223	40	31	36
Chul, C. I. 2227	64	94	79
Converse, C. I. 4141	8	4	6
Erivan, C. I. 2397	66	66	66
Garnet, Minn. 2203	16	13	15
Glyndon, C. I. 2870	11	10	11
Haynes Bluestem, C. I. 2874	5	12	9
Hope, C. I. 8178	23	5	14
Humpback, C. I. 3690	10	10	10
Huron, C. I. 3315	2	6	4
Java, C. I. 4966	37	70	54
Kitchener, C. I. 4800	26	95	70
Kota, C. I. 5878	48	20	34
Lynn, C. I. 6346	18	10	14
Marquillo, Minn. 2202	40	25	33
Marquis, C. I. 3641	17	40	28
Parkers Marquis, Minn. 2222	20	23	22

TABLE IV—Continued

PERCENTAGES OF HEAD BLIGHT IN WHEAT VARIETIES AND HYBRIDS GROWN IN DUPLICATE SERIES AT UNIVERSITY FARM, ST. PAUL, MINNESOTA, IN 1928

Variety and number	Percentage of heads infected		
	Series A	Series B	Average
Prelude, C. I. 4323	31	51	41
Progress, Minn. 2225	16	5	11
Quality, Minn. 2207	94	92	93
Red Fife, C. I. 3329	6	40	23
Red Saskatchewan, Minn. 2193	73	82	77
Resaca, C. I. 6390	10	10	10
Reward, Minn. 2204	70	84	77
Ruby, C. I. 6047	42	20	31
Sonora, C. I. 3036	95	90	93
Stanley, C. I. 4796	12	10	11
Webster, C. I. 3780	16	27	22
White Federation, C. I. 4981	67	95	81
Hybrids			
Kota x Marquis, Minn. 2242	89	77	83
Kota x Marquis, Minn. 2245	95	77	87
Kota x Marquis, Minn. 2244	93	84	89
Kota x Marquis, Minn. 2224	83	80	82
Kota x Natural Cross, Minn. 2240	6	6	6
Kota x Ruby, Minn. 2235	27	18	22
Marquis x Kota 1656-85, Minn. 2298	91	66	79
Marquis x Kota 1656-85, Minn. 2238	84	81	83
Marquis x Kota 1656-85, Minn. 2236	89	72	81
Marquis x Kota 1656-85, Minn. 2237	74	15	45
<i>Triticum durum</i>			
Acme, C. I. 5284	88	93	90
Akrona, C. I. 6881	57	18	38
Arnautka, C. I. 1494	3	19	11
Buford, C. I. 5295	70	81	76
D-46	85	83	84
Golden Ball, C. I. 6227	94	92	93
Iumillo, C. I. 1736	67	30	49
Kahla, C. I. 5529	77	70	74
Kubanka, C. I. 1440	98	87	93
Kubanka, No. 8, C. I. 4063	96	94	95
Mahoudi, C. I. 4592	89	100	95
Marouani, C. I. 1593	91	76	84
Mindum, C. I. 5296	68	79	73
Monad, C. I. 3320	89	73	81
Nodak, C. I. 6519	65	66	66
Peliss, C. I. 1584	83	60	72
Pentad, C. I. 3322	81	33	57
Sineuska, C. I. 4010	100	92	96
Velvet Don, C. I. 2222	94	33	64
Unnamed varieties			
C. I. 3172	12	19	15
C. I. 3192	92	97	95
C. I. 3193	93	90	91
C. I. 3196	85	96	91
C. I. 3207	1	0	1
C. I. 3231	86	90	88
C. I. 4918	90	92	91
C. I. 4919	95	97	96
C. I. 5112	3	8	6
<i>Triticum dicoccum</i>			
Khapli, C. I. 4013	95	98	97

TABLE V

CORRELATION BETWEEN REACTIONS TO FUSARIAL HEAD BLIGHT OF WHEAT VARIETIES GROWN AT DIFFERENT PLACES IN THE SAME YEAR, AT THE SAME PLACE IN DIFFERENT YEARS, AND IN DUPLICATE SERIES IN THE SAME YEAR\*

Species	Location and year of test	Head or seed infection correlated	No. of varieties or selections compared	Correlation coefficient
<i>Triticum vulgare</i>				
	Waseca, 1923 and 1925 .....	seed	41	$+.65 \pm .06$
	Waseca, 1923 and 1925 .....	head	41	$+.52 \pm .08$
	University Farm, 1923 and 1925	seed	41	$+.35 \pm .09$
	University Farm, 1923 and 1925	head	41	$+.32 \pm .07$
	University Farm, 1923 and			
	Waseca, 1923 .....	seed	41	$+.42 \pm .08$
	University Farm, 1925 and			
	Waseca, 1925 .....	seed	41	$+.59 \pm .04$
	University Farm and Waseca (Average 1923 and 1925) ....	seed	41	$+.60 \pm .07$
	University Farm, 1925 and 1926 .....	seed	41	$+.22 \pm .10$
	University Farm, 1925 and 1926 .....	head	41	$+.15 \pm .10$
	University Farm, 1925, Series A and B† .....	seed	41	$+.38 \pm .09$
	University Farm, 1925, Series A and B† .....	head	41	$+.19 \pm .10$
	University Farm, 1926 and 1927 .....	head	71	$+.02 \pm .08$
	University Farm, 1926 and 1927 .....	seed	71	$+.02 \pm .08$
<i>Triticum durum</i>				
	University Farm, 1926 and 1927 .....	head	154	$+.06 \pm .05$
	University Farm, 1926 and 1927 .....	seed	154	$+.05 \pm .05$
	University Farm, 1927, Series A and B† .....	head	116	$+.66 \pm .04$
	University Farm, 1927, Series A and B .....	seed	116	$+.62 \pm .04$

\* Some of these calculations were made by Dr. G. Nilsson-Leissner, as a part of a study of disease resistance while an International Education Board Fellow at the University of Minnesota.

† Series B was sown two weeks later than Series A.

TABLE VI  
SUMMARY OF CORRELATION COEFFICIENTS BETWEEN SEVERITY OF FUSARIAL HEAD  
AND SEED BLIGHT OF WHEAT

Species	Location and year of test	Extent of comparison	No. of varieties or selections compared	Correlation coefficient
<i>Triticum vulgare</i>	Waseca, 1923 and 1925 .....	Average for two years	41	$+.91 \pm .08$
	University Farm, 1923, 1925, and 1926 .....	Average for three years	41	$+.87 \pm .03$
	University Farm, 1926 and 1927	Average for two years	71	$+.92 \pm .01$
	University Farm, 1926 and 1927	Average for two years	154	$+.86 \pm .01$
<i>Triticum durum</i>	University Farm, 1927, Series A and B .....	One year	116	$+.87 \pm .02$

TABLE VII  
CORRELATION BETWEEN AVERAGE PERCENTAGES OF BLIGHTED HEADS AND OF BLIGHTED SEEDS IN  
TWO REPLICATED PLOTS OF DURUM WHEATS GROWN AT UNIVERSITY  
FARM, MINNESOTA, IN 1927

Average percentage of seeds blighted

Average percentage of heads blighted	F														
	3	9	15	21	27	33	39	45	51	57	63	69	75	81	87
6	2														2
12		3													3
18	2	3	1												6
24		4	4												8
30	1	2	1												4
36		3	3	2											8
42			2	4											6
48		1	1	1											3
54			2	1	1										4
60		1	1	1	2	3									8
66			1	3	4		2								10
72		1	2		2	2	1	1	1	1					10
78				5	6					1					12
84					1	4	3	1	3	1	1	1			15
90						1	1	2	1	2	1	1			9
96							2	1	2	1	1	1			8
F	5	15	13	12	8	14	16	9	5	7	5	3	3	0	1

$$r = +.866 \pm .016$$

TABLE VIII

CORRELATION BETWEEN AVERAGE PERCENTAGES OF BLIGHTED HEADS AND OF BLIGHTED SEEDS IN DURUM WHEATS GROWN AT UNIVERSITY FARM, ST. PAUL, MINNESOTA, IN 1926 AND 1927

Average percentage of seeds blighted

Average percentage of heads blighted	1.5	4.5	7.5	10.5	13.5	16.5	19.5	22.5	25.5	28.5	31.5	34.5	37.5	40.5	43.5	F	
2.5	2															2	
7.5	1	9														10	
12.5	6	4	3													13	
17.5	2	8	2													13	
22.5	1	6	2	4	3	1										17	
27.5	3	1	3	3	1											12	
32.5		1	4	4	3	1										14	
37.5			1	2	2	2	2	1	3	1						14	
42.5		1		3	3	5	4	3	1	3						24	
47.5			1		2	2	4		3	3	3	2				17	
52.5						1	2		1	1	1	1	1			7	
57.5						1	1		1			1				4	
62.5								2	1	1						4	
67.5								1				2				3	
	F	3	18	22	9	14	16	12	11	13	8	10	9	2	4	3	154

$$r = +.862 \pm .014$$

TABLE IX

EFFECT OF DATE OF SOWING ON DEVELOPMENT OF FUSARIAL HEAD AND SEED BLIGHT OF WHEAT AT UNIVERSITY FARM, MINNESOTA

Year	Date of sowing	Variety	Percentage of heads infected	Percentage of seeds infected
1923	April 27	Average of 52 varieties	4.9	..
	May 4		3.1	..
	May 12		T+	..
1925	April 23	Marquis, Minn. 1239	13.5	5.0
	April 30		2.5	0.7
	May 6		1.5	0.7
1926	April 23	Monad, Minn. 2156	32.5	14.4
	April 30		1.0	0.5
	May 6		0.5	0.3
1927	April 25	Average of 41 varieties	29.6	5.1
	May 8		7.4	2.2
1926	April 22	Average of 50 varieties	8.3	3.9
	May 4		T	T
1927	April 29	Marquis, Minn. 1239	5.7	2.5
	May 6		100.0	51.5
	May 13		86.7	43.8
	April 29	Monad, Minn. 2156	43.0	31.8
	May 6		100.0	80.0
	May 13		96.5	37.5

